

Claims

We claims:

- 1 1. A method for selecting multiple paths between a server and a client in an
2 overlay network having a plurality of nodes connected by links, the plurality
3 of nodes including the server and the client, each path including a set of
4 selected links, comprising:
5 measuring, in each node, quality of service metrics of each link
6 directly connecting the node to an immediate neighboring node;
7 transmitting the metrics to the server;
8 maintaining, in the server, the metrics, a link correlation matrix based
9 on the metrics, and a path correlation matrix based on the link correlation
10 matrix; and
11 selecting the multiple paths based only on the metrics, the link
12 correlation matrix, and the path correlation matrix.
- 1 2. The method of claim 1, further comprising:
2 streaming data from the server to the client via the multiple paths.
- 1 3. The method of claim 1, further comprising:
2 storing a copy of the data only at the server.
- 1 4. The method of claim 2, in which the streaming data are multimedia.
- 1 5. The method of claim 1, in which the link correlation matrix is

$$Cr(L_{ij}, L_{mn}) = 1/2 + \frac{E[(L_{ij} - \bar{L}_{ij})(L_{mn} - \bar{L}_{mn})]}{2\sqrt{E(L_{ij}^2) - (\bar{L}_{ij})^2}\sqrt{E(L_{mn}^2) - (E(\bar{L}_{mn}))^2}},$$

where ij and mn are a pair of links connecting two nodes, E is an expectation, L_{ij} and L_{mn} are the metrics for link ij and link mn , and an average $\bar{L}_{ij} = E(L_{ij})$.

6. The method of claim 1, in which the metrics include bandwidth, latency, and packet loss rate of the link.

7. The method of claim 1, in which the measuring, transmitting, maintaining, and selecting are performed dynamically and periodically over a time window.

8. The method of claim 5, in which the path correlation matrix is

$$Cr(Path_A, Path_B) = \sum_{a \in A} \sum_{b \in B} Cr(a, b),$$

where the path_A includes a link set $a \in A$ and the path B includes a link set $b \in B$.

9. The method of claim 8, further comprising:

first selecting a first path based on the metrics;

updating an available bandwidth of each link according to previously selected paths;

determining a correlation cost (cc) for each link L with respect to a previous selected link set S of a path as

$$Cr_S^L = \sum_{a \in S} Cr(L, a);$$

combining the correlation cost and the metrics to obtain a cost for
each link using a cost function

$$Cost_s^L = \alpha \cdot Cr_s^L + \sum_{i=1}^R \alpha_i W_r(i, j),$$

where W are the metrics, and α and α_i are weighting factors; and
selecting a next shortest path based on the updated cost $Cost_s^L$; and
repeating the updating, determining, combining, and selecting until
the plurality of paths have been selected.